

# The Need for a Standard Measure

## Materials

- *How Big Is a Foot?* by Rolf Myller (optional)
- Student Sheet 5 (1 per student)
- Student Sheet 6 (1 per student, homework)
- Rulers or inchsticks (1 per pair)
- Yardstick, tape measure (1 each for display)
- Stick-on notes or index cards (1 per student)

## What Happens

Students demonstrate their understanding of the value of standard measures as they respond to a story about a king who has difficulty communicating building directions to a carpenter. They are introduced to standard measuring tools and use rulers to collect data about the size of their feet. Their work focuses on:

- communicating ideas about the need for a standard unit of measure
- using a ruler as a standard measuring tool
- collecting data through measuring

## Activity

### Assessment

#### The King's Foot

"The King's Foot" is a story about a king, a carpenter, a horse stall, and the importance of agreeing on a standard unit of measure.

**Note:** *How Big Is a Foot?* has a similar theme. In this book, the carpenter's apprentice gets thrown in jail because the bed he makes for the queen is too small. If you can get this book, you can substitute it for "The King's Foot." At the point in the book when the apprentice is thrown in jail and the story asks, "Why was the bed too small for the queen?" pause so that students can respond in writing to this question, composing a letter to the carpenter's apprentice. See Introducing the Assessment Task, p. 31, for more explanation. This assessment was suggested by Marilyn Burns in *Math and Literature, K-3* (Math Solutions Publications, 1992), for use with *How Big Is a Foot?*

Introduce either story by relating it to the students' measuring experiences in this unit.

Earlier, we measured distances—like the length of our classroom, and how far it is from our room to the front door of the school—by pacing them off. We also tried using giant steps and baby steps. Here's a story about a king who measured the same way. Listen to find out how well it worked for him.

Read the story to your students. They might act out the story as you read it.

❖ **Tip for the Linguistically Diverse Classroom** If you are using the book *How Big Is a Foot?*, be sure to show the pictures as you read it. If you are reading "The King's Foot" aloud, having students enact the story will help make it comprehensible to students with limited English proficiency. Simple props (a king's crown, a yarn mane for the pony, a carpenter's hammer, an area marked off for the horse's stall) will also help.

## The King's Foot

Once upon a time there was a king who kept ponies. His daughter, the princess, had a little pony of her own that she dearly loved. As the princess grew older she grew bigger, but the pony did not. The day came when she climbed on her pony and her feet dragged on the ground. That was the day the king decided that he would surprise his daughter with a beautiful new full-size horse.

The king went to the best stable in the kingdom and chose a sleek Arabian mare. "Because it's a surprise," the king said, "I want to leave the mare here at your stable until I can get a new stall built in the royal barns to fit such a grand, large horse."

The king knew that he would have to tell the royal carpenter how large to make the stall. So, using heel-to-toe baby steps, the king carefully walked around the mare, imagining how big the stall for this beautiful horse should be.

"... 5, 6, 7, 8, 9 feet long," he murmured, "and 3, 4, 5 feet wide. I will tell the royal carpenter to build a stall that is 9 feet long and 5 feet wide."



*Continued on next page*

The king jotted down the numbers: 9 feet long and 5 feet wide. The message was sent to the carpenter, and she set to work at once.

Soon the stall was ready and the king sent for the mare. He thought he would have a little fun with the princess, so he had the royal groom hide the mare behind the barn. Then he said to the princess, "Come with me and see if you can guess your surprise."

Together they walked into the royal barn, past all the stalls of little ponies. They stopped in front of the empty new stall. But no sooner had the princess inspected the new stall than she burst into tears.

"I truly hoped that my surprise would be a horse, because I have outgrown my little pony. But now that I see the size of the stall, I know that you are just giving me another little pony, no larger than the first."

The king was puzzled. He saw that indeed, the new stall was much too small for a full-size horse. The groom quickly brought the new Arabian mare out of hiding, and as soon as the princess laid eyes on her, she forgot her tears. Only the king did not forget. He called angrily for the royal carpenter to account for her terrible mistake.

The carpenter was shocked. She knew she was good at her trade; her work always drew high praise. And she had made the stall just as the king had said—9 feet long and 5 feet wide. She had been very careful to use heel-to-toe baby steps, 9 feet long and 5 feet wide, when she measured the size of the stall. What could have happened?

*[At this point in the story, pause so that students can do the assessment task. See *Introducing the Assessment Task* (p. 31).]*

The carpenter stared sadly at her work. She paced thoughtfully around the little stall, carefully counting her foot-lengths. Then she sat down beside the king to think, staring at her feet.

That was when the carpenter noticed something—when she saw the king's foot next to hers. "That's it!" she cried. "Your foot is much longer than mine! I made the stall 9 feet long, but I used 9 of my feet instead of 9 king's feet."

Then the carpenter had a truly remarkable idea. She took a flat stick of wood, and she cut it just exactly the same length as the king's foot. "This way," she told the king, "I can always know exactly how big you want things made."

Now the carpenter made a stall for the new horse that was 9 king's feet long and 5 king's feet wide. This time the stall fit perfectly. So the king was happy, and the princess was happy, and the carpenter was happiest of all. She started a factory and made lots of sticks just as long as the king's foot, which she called rulers. Selling these sticks, she became rich and famous.

#### THE END



**Introducing the Assessment Task** Distribute Student Sheet 5, The King's Foot, to each student. (You will need to adapt this sheet if you are using *How Big Is a Foot?*)

The story is asking us what could have happened. Why was the stall that the carpenter built too small for the new horse? Before we finish reading the rest of the story, write a letter to the carpenter explaining what happened. Your letter should include an explanation of what went wrong, what she could do to correct the problem, and a diagram or picture to show why the stall was too small.

Students will probably need 15–20 minutes to compose their letters. Remind them that they should respond with mathematical arguments—that is, they should explain *mathematically* why the stall was too small. Encourage them to be clear and specific about their ideas and suggestions. See the **Teacher Note**, Assessment: The King's Foot (p. 34) for things to look for in student work and for a variety of student responses.

♦ **Tip for the Linguistically Diverse Classroom** Give nonnative speakers the option of writing the letter in their native language, or of concentrating on drawing the diagram or picture that shows what the carpenter could do to correct the problem.

When students have finished their letters, take a few minutes for them to share their ideas with the class; then finish reading the story.

## Activity

### Introduction to Measuring Tools

In the story we just read, the carpenter solved her problem by making a copy of the king's foot and using that as a measuring tool whenever she built something. Besides using the king's foot, there are other things you can use to measure with. What kinds of tools have you used when you measured, and what kinds of things did you measure?

Elicit children's ideas about how they have used different measurement tools in different situations; for example:

**Why did you use a tape measure, not a ruler, to measure the room?**

This emphasizes that certain tools lend themselves to certain situations. Show students different tools (rulers, a tape measure, a yardstick) as they are mentioned.

Explain that students will be using both metric measuring and U.S. Standard measuring in this unit, but that first they will be using only inches and feet.

Similarly, if you are using a yardstick marked on the reverse of a meter-stick, explain to students why you have covered the end of the stick beyond 36 inches (as directed on p. I-18).

Most students probably will not have seen or used an *inchstick* before. Introduce the inchstick as a measuring tool similar to the ruler, in that it is 12 inches long and is marked off in inches, but a tool that is less confusing than many rulers because it doesn't have extra lines. See the **Teacher Note**, Rulers and Inchsticks (p. 36), for further explanation.

Pass out rulers or inchsticks (at least one to each pair). Explain that they are going to collect some data about how big or long a third grader's foot is, and that for tonight's homework, they will be collecting more data by measuring the feet of the people in their homes.

**Deciding How to Measure Our Feet** Let students decide as a group how they will measure their feet. Explain:

Scientists collect data from measuring things, and sometimes they have to redo a whole experiment because different people measured things in different ways. Let's save ourselves this work and make some decisions first about how we'll measure.

- Should we measure with our shoes on or off? Would it make any difference?
- Where should we put the ruler?
- Should we stand up or sit down while we're measuring? Would that make a difference?
- What if the length is a little more than an inch-measure? Should we round down, round up, or use fractional parts of an inch?

Encourage students to try a variety of methods to see how their results for the same foot differ according to the method used. Give them a chance to talk about what they think gives a reasonable measure of foot length. Help them decide how to make the measurement standard for everyone. Write their agreed-on methods on the board for reference.

Ask students to measure their feet again, following the established method, and write their results on a stick-on note or index card. After they have finished measuring, collect their results on the board in an unordered list and save for tomorrow's class:

7 inches	6½ inches
9 inches	8 inches
7 inches	6 inches
8 inches	8 inches
9½ inches	

Make sure your list includes data from all students.

**Note:** After class, make a line plot of this data on an overhead transparency or chart paper. Keep this for use in a Session 2 activity, Comparing Kids' and Adults' Feet (p. 39).

## Session 1 Follow-Up

**Foot Length** Students collect more data by measuring the feet of people outside school and recording the measurements on Student Sheet 6, Foot Length. They will need to collect data from at least one adult. Have them write down the names of the people they measure, how old they are, and how long their foot is.

It is important that students have opportunities to decide how they will organize and record the data they need to collect. As you introduce this homework, spend a few minutes having students discuss and show ways they might record their family foot data.

**Exploring the History of Measurement** The history of measurement is fascinating to some students, and opens a real door to the past. Interested students may want to find out more about how our measurement systems have been developed and are enforced. They could look up early definitions of measures: How did the "foot" as we know it evolve, really? How was an acre defined? Many encyclopedias offer information on the evolution of measurements.

Your students may want to write for information about the history of weights and measures in the United States. Address such requests to National Institute of Standards and Technology, Office of Weights and Measures, Room A-617, Gaithersburg, MD 20899; phone (301) 975-2000.



### Homework



### Extension